

## OPTICAL PHENOMENA.

## HALOS.

The following are brief descriptions of the weather conditions attending or succeeding the occurrence of the most extensively observed halos of the month:

1st.—Both solar and lunar halos were reported from numerous stations in the Missouri Valley, upper Mississippi valley, and upper lake region, with lunar halos, only, in New England. They were followed on the 2d by lower pressure, and in New England by a heavy snow storm with high winds.

2d.—Lunar halos were observed at a large number, and solar halos, at a few stations in the Mississippi and Missouri valleys, Arizona, and California; they were accompanied in the valley districts by cirro-stratus clouds with haze, and followed on the 3d by rapidly falling pressure and cloudy weather.

3d-6th.—On the 3d rain or snow fell over the greater part of the northeastern quarter of the country, with clear or fair weather in all other sections; the area of cloudiness was surrounded on all sides by a strip of country in which halos appeared. They were also reported from stations in California, Arizona, and southern Texas. The 4th, 5th, and 6th were similar to the 3d, the area of cloudiness being surrounded by stations reporting halos.

7-8th.—Haze and cirro-stratus clouds partially covered the sky in the northern sections and were accompanied by solar and lunar halos with high, rising pressure. On the 8th the maximum pressure of the month in these districts occurred, and a number of stations reported halos.

9-30th.—From the 9th to 26th solar halos were noted at widely separated stations, and not generally in any district. The storm of the 27th, 28th, and 29th was preceded and followed over the central and eastern sections of the United States by solar and lunar halos which were reported from a large number of stations. On the night of April 30th and May 1st an area of heavy stratus clouds covered northern New England, the lower lake region, and the northern plateau and slope of the Rocky Mountains, in other districts light haze or fair weather prevailed, and the majority of the stations in the Mississippi Valley and eastern districts, except where the sky was entirely covered, reported lunar halos.

The phases of the moon, Washington mean time, during April, as given in "The American Ephemeris and Nautical Almanac" for 1887, are as follows: New moon, 22d, 15 h. 45.0 m.; first quarter, 30th, 5 h. 52.1 m.; full moon, 7th, 12 h. 30.8 m.; last quarter, 14th, 10 h. 55.6 m.; perigee, 6th, 18.6 h.; apogee, 19th, 9.4 h.

## MIRAGE.

Mirages were observed at the following places:

*California*.—San Francisco, 24th.

*Dakota*.—Parkston, 1st, 2d, 5th, 6th, 12th, 18th, 25th; Webster, 16th, 18th, 20th, 25th.

*Kansas*.—Salina, 2d, 6th, 7th, 23d, 29th.

*New York*.—Palmyra, 12th.

*North Carolina*.—Reidsville, 17th.

*Illinois*.—Lake Forest, 2d.

## MISCELLANEOUS PHENOMENA.

## FOREST AND PRAIRIE FIRES.

Huron, Dak.: on the morning of the 8th prairie fires were seen toward the north and south. A steady gale from the south and southeast prevailed throughout the day, attaining for twenty minutes between 6 and 7 p. m. a velocity of forty-eight miles per hour. The observer states that during this gale the fires were driven with incredible speed, and great masses of burning grass were blown miles ahead of the main body of flame; ordinary fire breaks or guards were useless. The heat was felt two and a half miles in advance of the flames. Much property was burned, and several lives were lost. Eighteen miles west of Sioux Falls a fire started and swept over miles of prairie, burning several farm houses, with barns, stock, and machinery. Several other large areas of country in the southeastern part of Dakota were burned over during the prevalence of this gale.

Valentine, Nebr.: on the 6th, 7th, and 8th prairie fires could be seen in all directions; these fires did great damage to settlers, many of whom lost all they possessed.

Atchison, Kans.: on the 11th a prairie fire started near Nicodemus, Graham Co., and moved rapidly toward the northwest before a high wind which was blowing at the time, burning a path two and a half to seven miles in width and about sixty miles in length. It is reported that large numbers of stock of all kinds were burned, and thousands of tons of hay, corn, wheat, as well as dwelling houses and barns, were destroyed by the flames. Large areas of land in Sheridan, Gove, and other counties in northwestern Kansas, and in Furnas county, Nebr., were burned over.

Forest or prairie fires occurred also at the following places: North Platte, Nebr., prairie fires, 1st, 2d, 7th, 28th; Yankton, Dak., prairie fires, 1st, 17th to 20th, 23d, 24th, 25th; Fort Reno, Ind. T., prairie fires, 3d; Fort Supply, Ind. T., prairie fires, 4th; Concordia, Kans., prairie fires, 4th, 28th; Stateburg, S. C., forest fires in various directions, 5th, 12th; Moorhead, Minn., prairie fires, 6th, 8th, 15th to 18th, 29th; Bismarck, Dak., prairie fires, 19th, 29th; Poplar River, Mont., prairie fires, 26th, 27th; Fort Buford, Dak., 29th.

## METEORS.

Meteors were reported as follows:

Yuma, Ariz., 1st; Fort Grant, Ariz., and Delavan, Wis., 18th; Willcox, Ariz., and Dover, N. J., 19th; New Haven Conn., 20th; Manatee, Fla., 12th, 17th; Sanford, Fla., 15th; Archer, Fla., 20th; Windsor, Ill., 14th, 22d; Charleston, Ill., 22d; Midway, Ky., 10th; Woodstock, Md., 13th; Cambridge, Mass., 8th; Kalamazoo, Mich., 1st, 2d, 10th; Raleigh, N. C., 24th; Stateburg, S. C., and University of Va., 11th; Rappahannock, Va., 9th; La Crosse, Wis., 21st, 25th.

## MIGRATION OF BIRDS.

*Geese flying northward*.—Wakefield and Manhattan, Kans., 1st; Bismarck, Dak., 1st, 4th; Poplar River, Mont., 1st, 5th, 6th, 7th; Fort Meade, Dak., and Dubuque, Iowa, 2d; Moorhead, Minn., 2d, 9th; Kitty Hawk, N. C., 4th; Fall River, Mass., 5th; Albany, Oregon, 6th, 7th, 10th, 12th, 13th, 16th to 19th, 23d to 27th; Readington, N. J., and Oswego, N. Y., 7th; Embarras, Wis., 11th; East Portland, Oregon, 12th, 26th; Charleston, Ill., and Fort Assinaboine, Mont., 13th; Archer, Fla., and Mackinaw City, Mich., 14th; Saint Vincent, Minn., 14th, 19th, 20th, 25th; Traverse City, Mich., 15th; Astoria, Oregon, 16th, 18th, 19th; Hay Springs, Nebr., and Bird's Nest, Va., 18th; Linkville, Oregon, 25th, 26th, 27th; Grand Haven, Mich., and Fort Bidwell, Cal., 26th; Fort Custer, Mont., 28th; Tatoosh Island, Wash., ducks and geese flying towards the north in great numbers nearly every day of the month.

*Geese flying southward*.—East Portland, Oregon, 4th.

*Geese flying westward*.—Kalamazoo, Mich., 3d; Yuma, Ariz., 10th.

*Ducks flying northward*.—Moorhead, Minn., 2d; Kitty Hawk, N. C., 4th; La Crosse, Wis., 9th; Saint Vincent, Minn., 19th.

*Ducks flying southward*.—Grand Haven, Mich., 2d; Saint Vincent, Minn., 9th.

*Cranes flying northward*.—Brownville, Nebr., 1st.

## POLAR BANDS.

Polar bands were reported from the following stations:

North Colebrook, Conn., 9th; Archer, Fla., 4th, 15th, 17th,

22d, 23d, 26th, 28th; Riley, Ill., 5th; Salina, Kan., 9th; Ninneseah, Kans., 30th; Moorestown, N. J., 22d; Wauseon, Ohio, 1st, 12th, 30th; Napoleon, Ohio, 1st, 5th, 30th; Mount Angel, Oregon, 14th; Memphis, Tenn., 2d; Nashville, Tenn., 16th; Wytheville, Va., 6th, 17th; Dale Enterprise, Va., 25th; Blakely, Wash., 9th; Prairie du Chien, Wis., 5th, 30th.

#### SAND STORMS.

San Carlos, Ariz.: about noon of the 7th a violent whirlwind passed over this station, carrying with it a column of sand and dust about two hundred feet in diameter and one thousand feet in height. The column revolved from right to left, and moved slowly from the southwest to the northeast. This was followed fifteen minutes later by a smaller but similar phenomenon.

Fort Grant, Ariz.: from 11 a. m. to 7 p. m. of the 15th a severe southeasterly gale prevailed, attaining a maximum velocity of forty miles per hour, and raising heavy clouds of sand which entirely obscured the sky, and at times rendered objects only a few yards distant invisible. Whirlwinds were numerous, and heavy sand drifts, resembling snow drifts in shape, were noticed after the storm. A number of trees along the creeks and several light buildings were prostrated. High winds, with sand storms, occurred also on the 7th and 8th.

Sand storms occurred also at the following places:

Abilene, Tex., 3d; El Dorado, Kans., 3d, 5th; Pekin, Ill., 4th; Fort McDowell, Ariz., 7th; Yuma, Ariz., 9th, 10th; Keeler, Cal., 17th, 30th.

#### WATER-SPOUTS.

Captain Hill, of the bark "Neptune," reports having ob-

served three large water-spouts at 1 a. m. on the 1st in N.  $32^{\circ} 0'$ , W.  $77^{\circ} 40'$ . The wind at the time was blowing a fresh gale from ssw., with rain squalls and rough sea. The bark "Bristol," on the 1st, at 2 p. m., in N.  $39^{\circ} 50'$ , W.  $68^{\circ} 0'$ , encountered a whirlwind which lasted twenty-five minutes. The water was carried into the air as high as the topgallant yard; the vessel sustained no damage.

Capt. James Lord, of the s. s. "Advance," reports having observed two water-spouts on April 9th, 4.30 p. m., in S.  $9^{\circ} 46'$ , W.  $34^{\circ} 40'$ . The spouts travelled ne. at a slow rate, and revolved with the sun, drawing water upward very rapidly. They were very narrow at the base. No change was noted in air temperature; the barometer fluctuated, and the wind was se., force 4, with almost clear weather, preceded by light rain showers.

Capt. Joseph Dove, of the s. s. "Roseville," reports having observed a dangerous water-spout April 18th, 4 p. m., in N.  $39^{\circ} 40'$ , W.  $55^{\circ} 00'$ , during the prevalence of a heavy nne. squall, accompanied by thunder and lightning.

Sanford, Fla.: on the 23d fresh southerly wind prevailed until 5.30 p. m., when it changed suddenly to northerly and blew for a time at the rate of thirty-six miles per hour. When the change in the wind direction occurred two water-spouts, each about thirty feet in height, formed on Lake Monroe.

#### SUN SPOTS.

Mr. H. D. Gowey, of North Lewisburg, Champaign Co., Ohio, reports having observed sun spots on the 19th, 21st, 23d, and 30th.

### VERIFICATIONS.

#### INDICATIONS.

The predictions for April, 1887, were made by 1st Lieutenant H. H. C. Dunwoody, 4th Artillery, U. S. Army, Acting Signal Officer and Assistant; they were verified by 1st Lieutenant Robert Craig, 4th Artillery, U. S. Army, Acting Signal Officer and Assistant.

The detailed comparison of the tri-daily indications for April, 1887, with the telegraphic reports of the twenty-four hours for which the indications were prepared, shows the general average percentage of verifications to be 77.66. The percentages for the different elements are: Weather, 81.37; wind, 72.36; temperature, 74.36. By states, etc., the percentages are: For Maine, 71.38; New Hampshire, 70.65; Vermont, 75.00; Massachusetts, 76.85; Rhode Island, 75.99; Connecticut, 77.84; eastern New York, 79.91; western New York, 77.10; eastern Pennsylvania, 78.68; western Pennsylvania, 76.34; New Jersey, 80.63; Delaware, 81.84; Maryland, 78.58; District of Columbia, 77.47; Virginia, 77.61; North Carolina, 80.26; South Carolina, 79.17; Georgia, 81.62; eastern Florida, 80.51; western Florida, 83.20; Alabama, 81.93; Mississippi, 84.73; Louisiana, 86.34; Texas, 88.36; Arkansas, 79.30; Tennessee, 78.01; eastern Tennessee, 77.50; Kentucky, 76.34; Ohio, 77.93; West Virginia, 77.93; Indiana, 75.52; Illinois, 68.19; eastern Michigan, 78.28; western Michigan, 75.30; Wisconsin, 73.02; Minnesota, 71.51; Iowa, 73.08; Kansas, 66.81; Nebraska, 70.30; Missouri, 66.44; Colorado, 70.54; eastern Dakota, 71.08.

There were eight omissions to predict, out of 8,508, or 0.09 per cent. Of the 8,500 predictions that have been made, seven hundred and thirty-seven, or 8.67 per cent., are considered to have entirely failed; two hundred and seventy-four, or 3.22 per cent., were one-fourth verified; 1,656, or 19.48 per cent., were one-half verified; 1,068, or 12.56 per cent., were three-fourths verified; 4,765, or 56.06 per cent., were fully verified, so far as can be ascertained from the tri-daily reports.

The predictions for the Pacific coast during April, 1887, were made at San Francisco, Cal., by 2d Lieutenant J. E. Maxfield, Signal Corps, U. S. Army, Assistant, and were verified by 2d Lieutenant Frank Greene, Signal Corps, U. S. Army, Assist-

ant. The percentages of predictions verified are: Washington Territory, 70.31; Oregon, 63.53; northern California, 79.42; southern California, 75.85.

Below are given for the Pacific coast the percentages of indications verified for March, 1887; this data was received too late for publication in the REVIEW of that date. The predictions were made by 2d Lieutenant J. E. Maxfield, Signal Corps, U. S. Army, Assistant; they were verified by 2d Lieutenant Frank Greene, Signal Corps, U. S. Army, Assistant. The percentages for the different districts are: Washington Territory, 77.62; Oregon, 71.36; northern California, 80.86; southern California, 84.87.

#### CAUTIONARY SIGNALS.

Of the total number of signals ordered during April, 1887, it was practical to determine the verifications of one hundred and twenty-six; of these, one hundred and eight, or 85.71 per cent., were fully verified both as to direction and velocity. Number of signals ordered for on-shore winds, one; verified, one, or 100 per cent. Number of signals ordered for northeast winds, eight; fully verified both as to direction and velocity; eight, or 100 per cent. Number of signals ordered for northwest winds, twenty-seven; fully verified both as to direction and velocity, twenty-two, or 81.48 per cent. Number of signals ordered without regard to direction, ninety; verified, seventy-seven, or 85.55 per cent. Number of signals ordered late, i. e., after the verifying velocity had begun, thirteen, or 10.32 per cent.

In addition to the above, two hundred and twenty-four signals were ordered at display stations, the verifications of which it was impracticable to determine.

In twenty-five instances winds were reported which would have justified the display of cautionary signals, but for which no signals were ordered, and in four instances winds which would have justified the display of on-shore signals, but for which no signals were ordered.

#### COLD-WAVE SIGNALS.

Total number of cold-wave signals ordered, the verifications